



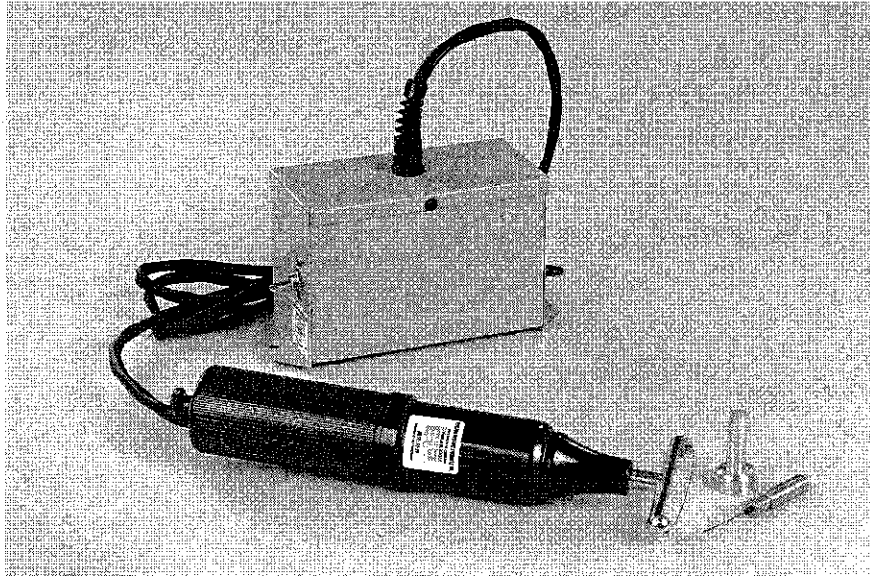
## ELECTRO-TECHNIC PRODUCTS

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### Model BD-20AC LABORATORY CORONA TREATER OPERATING MANUAL



## SECTION 1--GENERAL INFORMATION

### 1.1 Description

- 1.1.1 The Model BD-20AC and BD-20ACV High Frequency Generator produces a high voltage, high frequency spark at the tip of an electrode. The electric field created around the electrode is used for surface treating of polymers.
- 1.1.2 The Generator and associated electronic and mechanical assemblies are housed in a durable, Bakelite case which can be held comfortably in the hand. It is provided with a 6 ft. (1.8m) cord to permit ample movement over the work surface. Power is supplied by a transformer which is housed in a separate unit allowing better heat dissipation. This case is finished in a durable, silicone-painted surface which is resistant to scratches. Metal tabs are incorporated into the case for permanent mounting.

*Leak Testers, Corona Treaters, Science Education Products*

web site: [www.electrotechnicproduct.com](http://www.electrotechnicproduct.com)

e-mail: [sales@electrotechnicproduct.com](mailto:sales@electrotechnicproduct.com)

1.1.3 The Power Supply is furnished with a polarized and grounded power line cord 6 ft. in length. Operation is from 120 volts, 50/60 Hz.

1.1.4 The Model BD-20ACV is identical to the Model BD-20AC except that operation is from 230 volts, 50/60 Hz. A polarized and grounded line cord plus and 6 ft. line cord designed for operation from 230 volts is attached to the Power Supply, and is of the type and style for the country of use.

1.1.5 Both models include three electrode tips, as illustrated below.

## 1.2 Packing List

### 1.2 Packing List

1.2.1 Carefully remove the instrument and accessories for the packing materials. Check all parts against the Packing List. Report any shortages immediately.

Quantity	Part/Model No.	Description
1	BD-20AC	Power Supply and Generator, 120 V
1	BD-20ACV	Power Supply and Generator, 220V
1	12221	Electrode, Spring
1	12811	Electrode, Round, 1 in.
1	13811	Electrode, Field Effect, 3 in.
1	085-0057	Instruction Manual

### 1.3 Specifications

Output Voltage	10,000 to 48,000 volts
Frequency	4 to 5 MHz
Operating Duration	Intermittent maximum 20 minutes ON with similar time OFF for cool down.
Input Voltage	115 V, 50/60 Hz (BD-20A) 220 V, 50/60 Hz (BD-20AV)
Generator (1xd)	11 x 2-1/2 in. (28x6.4 cm)
Power Supply (h x w x d)	4-1/8x7-3/4x3-1/8 in. (10.5x19.7x8 cm)
Shipping Weight	BD-20AC: 8 lbs (2.7 kg) BD-20ACV: 9 lbs (3.2 kg)

### 1.4 Warranty Repair / Replacement Information

- 1.4.1 If the unit requires repair, forward it freight prepaid to Electro-Technic Products, Inc. Please request a Return Authorization Number prior to sending it in.
- 1.4.2 Electro-Technic Products, Inc. reserves the right to repair or replace any unit sent in for warranty repair.
- 1.4.3 If found to be out of warranty, or damaged due to improper use, it will be repaired for a minimal labor and parts charge. We will advise the customer prior to any work being done.

## **SECTION 2 - INSTALLATION**

### **2.1 Installation**

2.1.1 For best results the instrument should be located away from sources of heat or air conditioners. Avoid areas of high humidity or highly corrosive atmospheres; if operation is required under any of these conditions, use intermittently and remove to another location for storage.

2.1.2 Do not use near flammable liquids or explosive gases.

2.2.2 The instrument is designed for operation from either 120 volts or 240 volts, 50/60 Hz, as marked on the instrument. Connect the power line cord to its matching three wire power line receptacle. This provides power properly polarized and grounded. Operation in any other way will result in a potential shock hazard and may affected the performance of the instrument.

### **2.3 Accessory Information**

2.3.1 Push the electrode into its matching socket in the Generator. To remove the electrode, firmly grasp the metal base of the electrode which protrudes about 1/4 in.(6mm) from the case and gently rock back and forth while pulling it out. Do not grasp by the spring. Do not install or remove electrode while in operation.

2.3.2 Do not use any electrodes in the Model BD-20AC with a white plastic spacer that separates the electrode from its base. These are intended to be used only with the Model BD-10, BD-40, BD-50, and BD-60 series of High Frequency Generators.

## **SECTION 3-OPERATION**

### **3.1 Operation Controls**

3.1.1 Power ON/OFF Switch. It is located on the side of the Power Supply case. In the ON position, circuitry is energized.

3.1.2 High Voltage Adjust Knob. It is located on the end of the Generator case opposite the electrode. It adjusts the spark length by changing the spacing between the tungsten contacts inside. A counterclockwise rotation increases the spark length.

## 3.2 Calibration

3.2.1 The instrument requires no user calibration.

## 3.3 Operation

- 3.3.1 Once the power line cord plug has been properly connected to the source of power, the unit is ready to use. Bring the electrode tip near a large metal object or a ground connection. Turn the Power Switch to the ON position. If no spark is seen to jump from the electrode, the spark is being confined between the two internal tungsten contacts in the Generator. An associated electric field can be felt near the location of the tungsten contacts located opposite the electrode side of the Generator.
- 3.3.2 Turn the High Voltage Adjust Knob **counterclockwise** until the spark is seen to jump from the electrode to the metal surface. Continuing to turn the knob counterclockwise will increase to output until the maximum output is achieved. Continuing to turn the knob counterclockwise beyond this point will cause the circuitry to go out of resonance, and the output will abruptly go to zero. If this occurs, turn the knob **clockwise** until the resonance is reestablished, and the maximum output is attained. Continuing to turn the knob clockwise will decrease to output until the circuitry is again out of resonance, at which point the output will again abruptly go to zero. The travel of the knob from minimum to maximum output is about 1-3/4 turns.
- 3.3.3 Continue to adjust the output of the spark until the desired length (output) is attained. A nearly linear relationship exists between spark length and spark voltage. A one inch (m) spark represents peak voltages of approximately 50,000 volts, with a one half inch (13mm) spark a proportional 25,000 volts. Adjust the length of the spark most suitable for the application. Usually the proper spark length is determined through experience; however, the shortest possible spark length should be used to achieve the desired effect.
- 3.3.4 The basic principle of operation is that of a tesla coil which is a special type of induction coil generating a high frequency, high voltage. Refer to the Schematic Wiring Diagram at the end of this instruction manual. The power transformer T1 sets up a high voltage which causes a spark gap to break down at the rate of twice the line frequency (100 or 120 Hz). The spark gap charges capacitors C1 and C2 which are connected to the primary windings of the resonator coil T2 which is an air core rather than the iron core found in standard transformers. Because of the inductance of the primary windings of T2 and the capacitors, an oscillating current of very high frequency is set up in the circuit. When the spark gap is adjusted to the resonant frequency of the circuit (of the order of megahertz) frequency, high voltage is induced in the secondary windings of T2. This voltage is brought out to the electrode.

### 3.4 Corona Surface Treating

3.4.1 The surface of polymers is modified by corona treatment at a characteristic rate which varies from material to material. Furthermore, the degree of treatment or extent of surface modification required, will depend on the particular application.

3.4.2 The guidelines below are given to help determine the optimal conditions for a particular application, as the surface effect produced by corona treatment depends upon the following:

- treatment time, see Section 3.4.3
- power level, see Section 3.4.4
- distance between electrode / surface to be treated, see Section 3.4.5
- electrode size and shape, see Section 3.4.6
- area being treated, see Section 3.4.7
- material being treated, see Section 3.4.8
- decay of surface energy with time, see Section 3.4.9
- use of ground plane, see Section 3.4.10

3.4.3 Treatment Time. The most important variable in nearly all applications is treatment time. Treatment effect, measured by an increase in surface energy, is approximately an exponential function of time as indicated in Figure 3.1. As shown, most of the treatment effect occurs quickly. The characteristic time,  $t^*$ , is determined by electrode size, power, etc.

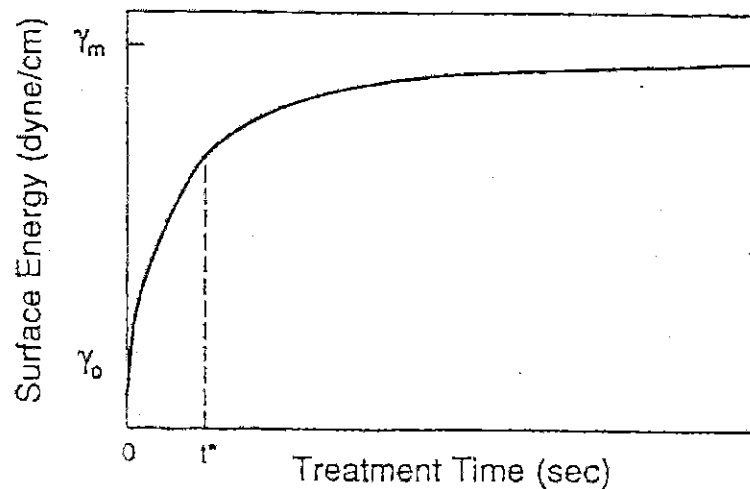
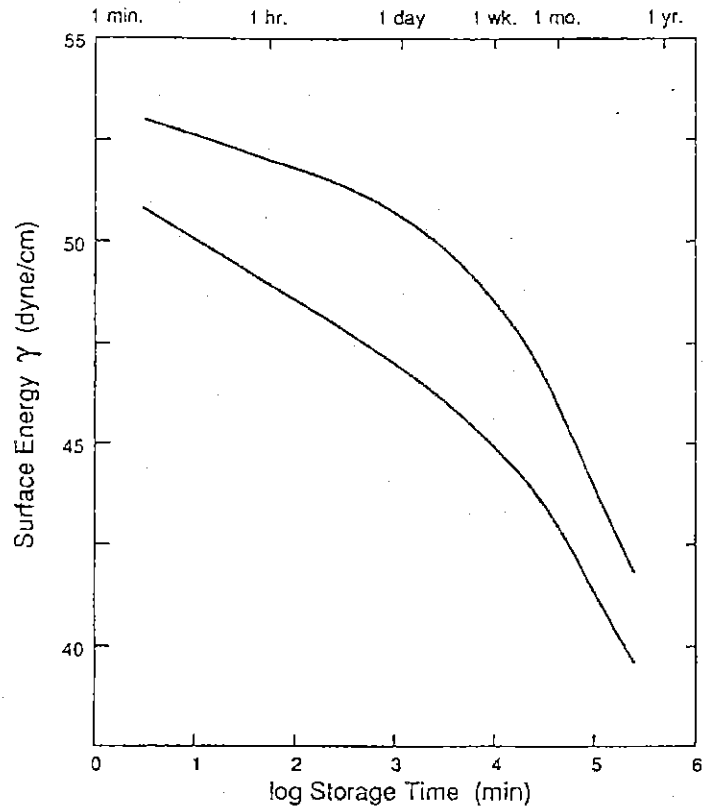


Figure 3.1 Surface Energy vs. Treatment Time

- 3.4.4 Power. Power is adjusted by the control knob of the end of the handle. The product of power and time is effectively constant for any application. In other words, reducing the power in half will double the time required to obtain the same treatment, when all other parameters are held constant.
- 3.4.5 Distance between electrode and surface. The distance between the electrode and the surface to be treated can be varied. Normally the most efficient treatment is obtained at distances between 1/8 in. and 1/4 in. Significant treatment can still be obtained at distances as large as 2 in., though treatment times become longer.
- 3.4.5.1 For example, the treatment done in 0.25 seconds at 1/2 in. may take 15 seconds to do the same treatment at a distance of 1 1/2 in. A qualitative feel for the distance over which the corona is effective can be obtained by visual inspection of the purple corona. This is best done in a darkened room.
- 3.4.5.2 A metallic conductor within about 2 in. of the electrode (a floating ground plate) will pull the corona in the direction of the plate. This may permit more efficient treatment at larger distances from the electrode, but the treated area is somewhat smaller. The conductor may be quite thin (e.g., copper clad printed circuit board material, standard aluminum foil), but it must be covered with a dielectric to prevent arcing from the electrode.
- 3.4.6 Electrode Size and Shape. Two electrodes are furnished, a circular and a field-effect electrode. Larger sized electrodes in these shapes are not practical for use with the Model BD-20C because of the power limitations of the unit.
- 3.4.6.1 The circular electrode is used primarily to treat flat surfaces. The diameter of the electrode may be about 1 in. less than the maximum width of the surface to be treated.
- 3.4.6.2 The field-effect electrode is used to treat thick or irregularly-shaped surfaces. These patented electrodes can project the corona up to 2 in.
- 3.4.6.3 The Engineering staff of Electro-Technic is available to assist customers by developing new electrodes or adapting existing electrodes for particular applications. However, the Model BD-80 Corona Surface Treater, used in production and industrial applications, has much more output power than the Model BD-20AC; hence many more standard and custom electrodes are available for this unit.
- 3.4.7 Treated Area. The treated area is determined by several factors, including the electrode size and shape, power and time. A larger electrode will treat a larger area, but the effect at any one point will take longer to occur.

3.4.7.1 The function:  $[(\text{time} \times \text{power}) / \text{area}]$  is an effective constant. So doubling the treated area (by using an electrode which is twice the size) will require twice the time to achieve the same treatment level if the power setting is unchanged.

3.4.8 Material Treated. See Figure 3.1. The untreated surface energy ( $\gamma_0$ ) and the maximum surface energy obtained by corona treatment ( $\gamma_m$ ) depend on the material. The amount by which the surface energy is to be increased must be established for each application.

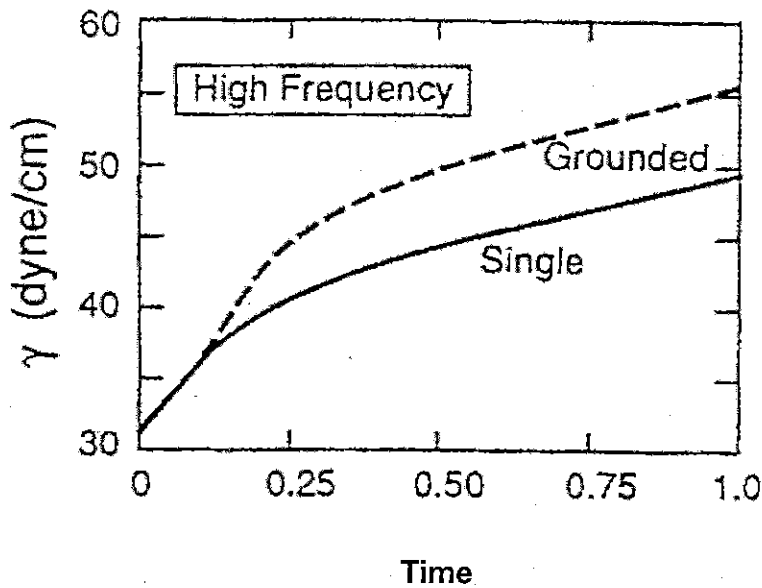


**Figure 3.2 Surface Energy vs. Treatment Time**

**3.4.10 Use of Ground Plane.**

See Figure 3.3. It shows the surface energy vs. time in seconds with a single electrode (no ground plane), and with a metal plate underneath the surface to be treated. The ground plane helps to direct more of the corona to the surface, but does cause a slight reduction in the treated area.





Figure

3.3 Surface Energy vs. Treatment

### 3.5 Hazards

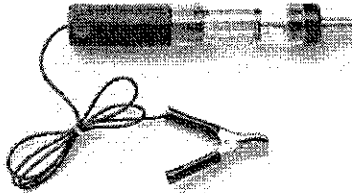


- 3.5.1 This instrument emits a high frequency, high voltage spark. Keep the electrode tip away from the body. Care should be taken to avoid letting the spark be attracted to metal objects worn on the body such as rings and jewelry. A spark to the body will not cause harm, but might cause a slight discomfort, like the sensation felt when a spark jumps from the finger tip to a metal object after having walked across a carpet on a dry day. The output of the instrument is at a very low current. Also, the skin of the body has a very high resistance to the high frequency current, causing any current to flow harmlessly over the skin.
- 3.5.2 Do not operate in or around flammable liquids or gases as the spark may ignite them.
- 3.5.3 Ozone gas is generated around the tip of the electrode when oxygen in the air is ionized. The gas has a pungent odor, but is harmlessly dissipated in a normally ventilated area. Do not use in a confined area where high concentrations of ozone gas can develop.
- 3.5.4 This instrument generates an output at the radio-frequency level. Users who wear a pacemaker or other medical electronic device which might be affected by radio-frequency waves are advised to consult a physician before using this instrument.

## SECTION 4 - MAINTENANCE

### 4.1 MAINTENANCE / INSPECTIONS

4.1.1 If the output level of the Model BD-20AC is required to be verified when this instrument is in use, check the output with a Model 12701 Peak Voltage Calibrator, shown below.



- 4.1.2 The High Frequency Mixer contains no user adjustable components inside either the Power Supply or Generator. Any attempt at repair while the instrument is in warranty may result in any future in warranty service being denied.
- 4.1.3 Several components will exhibit wear with extended use and will eventually require replacement. The failure modes of several of these components are very similar to what causes the failure of a tungsten-filament incandescent light bulb after extended use.
- 4.1.4 Due to a combination of corona discharge, high voltage and high temperature, the insulation in the capacitors and resonator coil may fail. Corona discharge develops around microscopic bubbles within the insulation material. Within time the corona discharge creates larger bubbles, the process accelerating until eventually a voltage breakdown occurs.
- 4.1.5 In time the tungsten contacts will require replacement in order to maintain the proper setting of the high voltage output.
- 4.1.6 When used continuously or for an extended period of time, the tungsten contacts will begin to evaporate and condense on the plastic molded base of the 035-0002 Generator Mechanical Assembly, causing a short to develop across this component.
- 4.1.7 It is recommended that whenever this instrument requires service, it be returned to the factory or distributor postpaid, with a statement concerning the problem. The instrument will be repaired promptly for a small labor and parts charge.

## 4.2 Repair



**CAUTION.** Take precautions not to touch any wires, as power to be unit may have to be applied with the cover removed to perform certain of these operations.

4.2.1 Only personnel familiar with electronic circuitry should attempt repair. If it is necessary to repair while either the Power Supply cover or Generator housing are removed, be cautious as high voltage will be present at various locations in the circuitry. Refer to the Schematic Wiring Diagram at the end of this manual.

4.2.2 The Power Supply cover is removed as follows:

- a) Remove the two screws from the side flap of the cover.
- b) Carefully lift the cover from the case and move to the side. The wiring to the generator is attached to the transformer by two quick-disconnect terminals. Carefully disconnect these terminals.

4.2.3 The Generator housing is disassembled as follows:

- a) Remove the electrode from the socket.
- b) Carefully remove the recessed hex nut holding the electrode socket to the threaded nylon stud attached to the resonator coil. Remove the electrode socket.
- c) Turn the High Voltage Adjust Knob fully counter clockwise. Place a small wrench on the flattened portion of the shaft to hold it from turning while the knob is turned counterclockwise and removed from the shaft.
- d) Note the number of washers around the shaft and remove. Washers are placed on the shaft to prevent the possibility of the two tungsten contacts inside the housing from shorting whenever the High Voltage Adjust Knob has been turned fully clockwise. The number of washers will vary from unit to unit, from none at all to as many as three.
- e) Remove the wax covering the two screws on the Generator housing near the High Voltage Adjust Knob and remove the screws.
- f) The Generator housing is in two parts. Grasp the grooved portion and turn the other portion counter-clockwise to remove.
- g) Carefully remove the electronic and mechanical assemblies from the grooved portion of the housing. The high voltage cord set attached to the electronics will prevent the complete removal of the assemblies from the housing.

- 4.2.4 The factory maintains stock of replacement parts. Consult the Parts list. A Parts Price List is available upon request. .
- 4.2.5 Refer to Section 4.1.2 for assistance in troubleshooting possible failure modes. If the Generator were accidentally dropped on the High Voltage Adjust Knob, it may be necessary to replace the 059-0004 Bridge Yolk Assembly to repair the unit.
- 4.2.6 Once repair is completed, carefully reassemble the Power Supply cover and Generator housing.
- a) Reinstall the proper number of washers on the shaft of the Generator. When any of the mechanical components of the Generator are replaced, the number of washers required after repair may be different than before. Use a sufficient number of washers to preclude the possibility of the tungsten contacts from shorting.
  - b) Replace the protective wax over the two screws on the Generator housing.

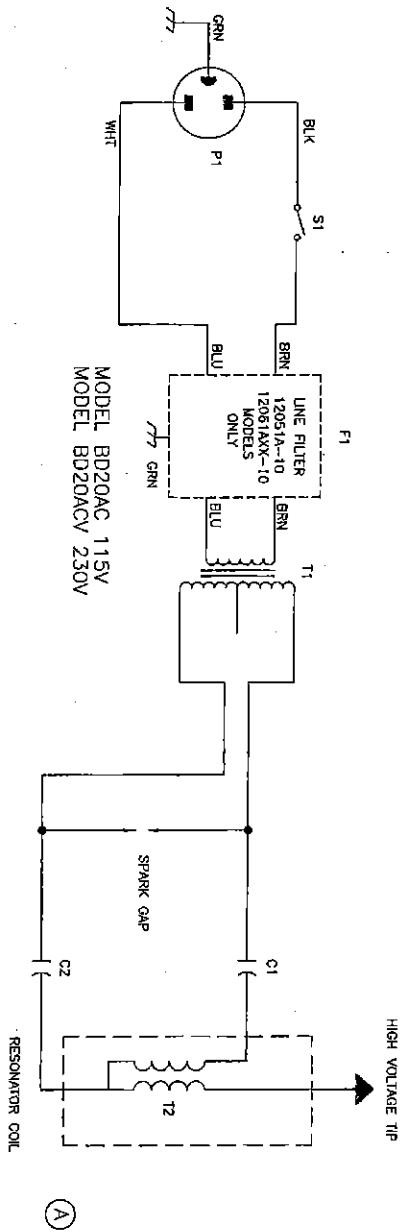
## SECTION 5 - PARTS LIST

5.1.1 Contact Electro-Technic for parts price list.

<i>Part Number</i>	<i>Schematic Code</i>	<i>Description</i>
001-0012-1		Screw, 2-56 X 3/8
001-5085-3		Screw, Nylon, Resonator, 10-32 x 1-1/2
002-0005-1		Nut, 10-32, Hex, for Electrode Socket
002-0007-1		Nut, 2-56, Hex
010-0002-1	T1-115 V	Transformer, 115 V
011-0004-1	T2	Resonator Coil
021-0057-1	C1, C2	Capacitor, 0.0025 uF, 10 kV
023-0024-1		High Voltage Cord Set, 6-1/2 ft
025-0003-1	C1, C2	Printed Circuit Board and Capacitor Assembly
027-0055-1	F1	Power Line Filter
035-0002-1		Complete Top Mechanical Assembly
035-0003-1		Top Spring Rivet Contact Assembly
035-0004-1		Bottom Contact Assembly
035-0025-1		Bridge w/Posts, Ratchet Spring, Adjusting Screw with Tip (Top Assembly)
040-0004-1		Bracket, Right Angle, for Circuit Board
044-0002-1		Top Housing, Cone, with Eyelet
044-0004-1		Bottom Housing, Line Cord Side
044-0005-1		Adjusting Knob
044-3006-1		Top Mechanical Assembly Base
045-0003-1		Electrode Socket
049-0025-1		Nut Driver, 5/16 in.
050-0010-1		Contact Bushing
050-0037-1		Tungsten Screw Contact
059-0004-1		Bridge Yoke and Bushing
059-0008-1		Adjusting Screw Assembly
059-0040-1	S1	Switch, Toggle, SPST, w/leads attached
060-0002-1	P1-115 V	Line Cord Set, 3 Conductor, 115 V
060-000X-1	P1-230 V	Line Cord Set, 3 Conductor, 230 V, Specify Type
080-1203-1		Generator, w/o Power Supply, BD-20A, w/Terminals
080-1205-1		Power Supply, BD-20AC, 115 V
080-1206-1		Power Supply, BD-20ACV, 230 V, Specify Plug Type
083-0010-1		Housing, Bakelite

ALL DIMENSIONS IN INCHES UNLESS OTHERWISE SPECIFIED  
 TOLERANCES DECIMAL ± .005 FRACTIONAL ± 1/64 ANGLES ± 1°  
 UNLESS OTHERWISE SPECIFIED

REVISIONS				
LOC.	REV.	DESCRIPTION	DATE	APPROVED
B1	A	GENERATOR HARDWIRED TO POWER SUPPLY	06/28/97	JTC



MODEL BD20AC 115V  
 MODEL BD20ACV 230V

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<b>ETP</b>		ELECTRO-TECHNIC PRODUCTS, INC.	
CHICAGO, ILLINOIS 60640-4510		DRAWN BY: GREG	
DATE: 02-12-97		REVISED: 01-14-10	
DESCRIPTION: BD20AC/BD20ACV CIRCUIT SCHEMATIC		PART NUMBER: BD-20AC	